Numerical investigation of slow-mode shock waves in 1D simulations of thin current layer decay.

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Abstract

In this study we investigate one-dimensional decay of a thin plain current sheet which is perturbed by a weak magnetic field normal to the current sheet. Results of 1D Magnetohydrodynamic (MHD) and Particle-in-Cell (PIC) simulations are compared to the analytical MHD solution based on Rankine-Hugoniot relations. Such 1D formulation is suitable for studying dynamics of a single reconnected flux tube far from the diffusion region and resolves the shock waves generated by magnetic reconnection. MHD simulations are found to be in a good agreement with analytical solution. PIC simulations show the presence of pick up process in the exhaust which leads to mostly perpendicular acceleration of ions in the outflow region, with mostly parallel acceleration of ions at the edge of the exhaust region. Antiparallel case sees the formation of a wave train which we interpret as a slow mode shock wave. For guide field case (equal guide field/antiparallel components), the reconnection layer is a combination of Alfven discontinuity and slow mode shock. In antiparallel and weak guide-field case, the firehose instability is found to perturb the exhaust layer.